

MICROPLANKTON FROM THE BROWNS CREEK CLAYS, SW. VICTORIA

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Abstract

Two new genera and 13 new species of microplankton from the Upper Eocene clays at Browns Ck, Aire District, SW. Victoria are described.

Introduction

The microplankton content of the Upper Eocene Browns Creek Clays (Carter 1958) is rich in both quantity and species. So far only 5 species have been identified (Cookson 1965). In the present contribution an attempt will be made to give a more complete picture of the assemblage as a whole and, as far as possible, the distribution of the types identified. As previously noted the samples examined represent a carbonaceous clay A (25 ft below greensand), the greensand B, a calcareous clay 15 ft above greensand C, a carbonaceous clay D (not D.J.T. sample) about 40 ft above greensand, and a gritty clay E 50 ft above greensand.

The samples were generously provided by Mr D. J. Taylor, Mines Department of Victoria. Holotypes and paratypes are in the palaeontological collection of the National Museum of Victoria. Numbers prefaced by the letter P are registered numbers in that collection.

Systematic Descriptions

Class DINOPHYCEAE

Family PERIDINIACEAE

Genus *Peridinium* Ehrenberg

Peridinium eocenicum n.sp.

(Pl. 11, fig. 1-5; holotype fig. 1, 2, P24085)

AGE AND OCCURRENCE: Upper Eocene: Browns Creek Clays, SW. Victoria, carbonaceous clay 25 ft below greensand; greensand and calcareous clay 15 ft above greensand.

DESCRIPTION: Shell small, oval, tabulated and divided almost equally by a relatively broad, helicoid girdle. Both cpitheca and hypotheca with a small, solid horn. Wall of shell finely granular with or without small dot-like thickenings of variable size on the surface of the plates (Pl. 11, fig. 5). The borders of the girdle and the thin transparent ledges of the plates are lightly granular and their edges dotted with evenly spaced granules and small tubercles, or sparsely denticulate.

Tabulation is of the *Peridinium* type, 4'?, 3^a, 7'', 5''', 1p, 2'''''. Plate 1' is kite-like in shape, the two upper sides of the 'rhomb' being shorter than the two lower. Plate 1''' is very narrow. Intercalary strips are sometimes evident. The archeopyle is relatively large, hexagonal, and intercalary.

DIMENSIONS: Holotype—c. 60 μ long, 40 μ broad. Range—c. 48-62 μ long, 33-48 μ broad.

COMMENT: As far as we know this is the first record from a Tertiary deposit of a form clearly comparable with the genus *Peridinium*. Unlike previous records based on specimens preserved in Cretaceous flints, the Browns Ck specimens were isolated by treatment with hydrofluoric acid, followed by oxidation with nitric acid and clearance with weak alkali.

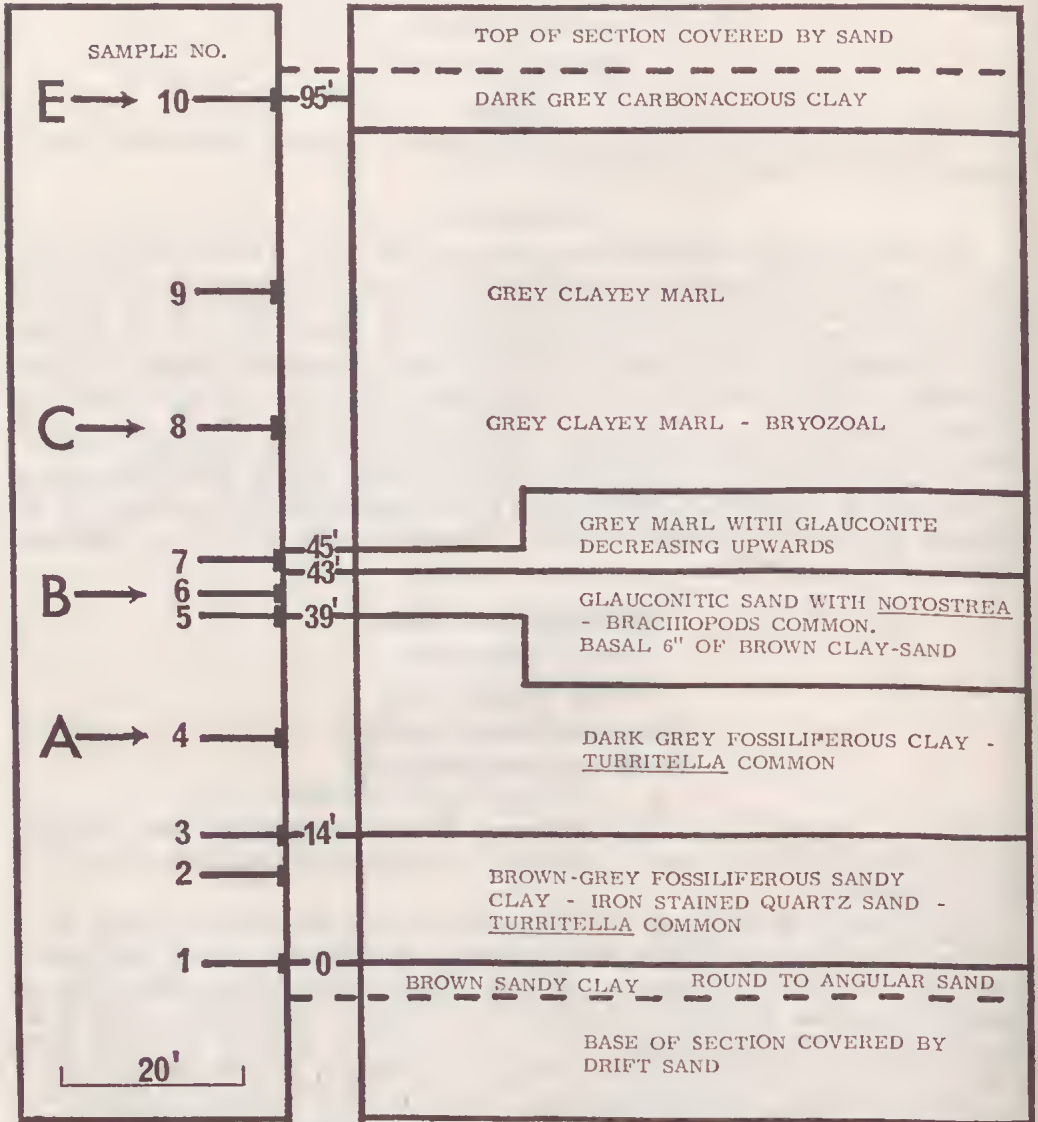


FIG. 1—Measured Section of Browns Creek Clays (section in first gully W. of Browns Ck). Column based on Abney and metallic tape traverse by Hocking, McGowran, & Taylor, Oct. 1963. Sample D is not in this series of sampling.

Family DEFLANDREACEAE

Genus *Deflandrea* Eisenack*Deflandrea phosphoritica* Eisenack

(Pl. 11, fig. 11)

Deflandrea phosphoritica Eisenack 1954, p. 52.

AGE AND OCCURRENCE: Upper Eocene: Browns Creek Clays, SW. Victoria, carbonaceous clay, 25 ft below greensand (infrequent) to gritty clay 45-50 ft above greensand (numerous) inclusive.

COMMENT: The Browns Ck examples agree in general features with those of the type locality in East Prussia. However, some examples show variations which link them closely with the examples from Spitsbergen referred to *D. phosphoritica* by Manum (1960). These are—(1) a partial granulation of the shell wall, in the Victorian specimens restricted to the lateral margins and surface of apical horn (Pl. 11, fig. 11); (2) the presence of a short 'solid papilla' at the tip of the apical horn; (3) the presence of patterned and unpatterned areas on the surface of the capsule; (4) the presence of small thickenings on the wall of the capsule.

An interesting feature in some of the more favourably presented examples (Pl. 11, fig. 11) is the occurrence of the short concavo-convex thickening, in the middle of the lower portion of the ventral surface, recently demonstrated in 4 Victorian species of *Deflandrea* and a species of *Ginginodinium* and believed to be associated with the flagellar pore (Cookson & Eisenack 1965a, b).

Deflandrea cf. *heterophlycta* Deflandre & Cookson

(Pl. 11, fig. 10)

Deflandrea heterophlycta Deflandre & Cookson 1955, p. 249.

AGE AND OCCURRENCE: Upper Eocene: Browns Creek Clays, SW. Victoria, carbonaceous clay 40 ft above greensand, gritty clay 45-50 ft above greensand.

COMMENT: Specimens with the general characters of *D. phosphoritica*, but with tuberculate thickenings on the wall of the capsule, similar to, but less prominent than those of *D. heterophlycta*, are not uncommon in the upper beds of the Browns Creek section. Furthermore, the shape of the shell differs from that of the holotype of *D. heterophlycta* and more particularly that of additional specimens of this species recently isolated from the type locality at Castle Cove, Victoria. Since, hitherto, the holotype has been the only complete specimen of *D. heterophlycta* known, the new examples have been illustrated (Pl. 12, fig. 1, 2) for comparison with the Browns Ck form hereinafter questionably referred to as *D. cf. heterophlycta* on the one hand and the extension of our knowledge of the species *D. heterophlycta* on the other. In them the abundance and prominence of the tubercles and the difference in their arrangement on the ventral and dorsal surfaces, not hitherto observed, are features of special interest.

Deflandrea leptodermata n.sp.

(Pl. 11, fig. 6, 7; holotype fig. 6, P24093)

AGE AND OCCURRENCE: Upper Eocene: Browns Creek Clays, SW. Victoria, greensand and carbonaceous clay 25 ft below greensand.

DESCRIPTION: Shell untabulated, longer than broad with strongly convex sides, a short, blunt apical horn and two short, broad, slightly pointed antapical horns. Girdle usually not indicated. Wall of shell thin, distinctly granular. Capsule large,

circular in outline, almost filling the shell, wall very thin and densely granular. Archeopyle usually indistinctly outlined, broader than long, possibly 6-sided. In the specimen shown in Pl. 11, fig. 7 the basal suture of the archeopyle is evident as a fine line crossing the upper part of the shell at a right angle.

DIMENSIONS: Holotype—118 μ long, 92 μ broad. Range—87-123 μ long, 78-102 μ broad.

COMMENT: *D. leptodermata* appears to be restricted to the lower portion of the Browns Creek section. It is infrequent in the greensand.

Deflandrea granulosa n.sp.

(Pl. 11, fig. 8, 9; holotype fig. 8, P24095)

AGE AND OCCURRENCE: Upper Eocene: Browns Creek Clays, SW. Victoria, carbonaceous clay about 40 ft above greensand, gritty clay 45-50 ft above greensand.

DESCRIPTION: Shell longer than broad, thin-walled, untabulated with slanting to convex sides, a short, blunt apical horn of rather variable shape and size and two blunt antapical horns. Girdle indistinct, indicated by two median lateral indentations. Shell wall densely and finely to coarsely granular. Capsule large, circular in outline, nearly filling the main portion of the shell, rather thick-walled, densely and finely to coarsely granular, occasionally with small blunt tubercles. Archeopyle large, widely hexagonal.

DIMENSIONS: Holotype—c. 118 μ long, 68 μ wide, capsule c. 62 \times 71 μ . Range—c. 94-128 μ long, 68-102 μ wide, capsule 62-72 μ \times 68-82 μ .

Genus **Scriniodinium** Klement

Scriniodinium australiense (Deflandre & Cookson) 1955

(Pl. 13, fig. 15)

Gymnodinium australiense Deflandre & Cookson 1955, p. 248.

Scriniodinium australiense Deflandre & Cookson; Gerlach 1961, p. 173.

OCCURRENCE: Upper Eocene: Browns Creek Clays, SW. Victoria, carbonaceous clay 25 ft below greensand, carbonaceous clay about 40 ft above greensand.

COMMENT: The specimens from Browns Ck are closely similar to those from the type locality of the Balcombian Stage at Balcombe Bay, SE. Victoria. A few have shown slight indications of an antapical prominence, a feature not mentioned in the original description. The surface of the examples from the carbonaceous clay at 40 ft above the greensand differs from typical examples of *S. australiense* in having a surface pattern composed of small polygonal areas. It is possible that this form is specifically distinct but, for the present, a specific separation on this feature alone seems inadvisable.

Family GONYAULACACEAE

Genus **Leptodinium** Klement

Leptodinium dispertitum n.sp.

(Pl. 12, fig. 5-7; holotype fig. 5, 6, P24097)

AGE AND OCCURRENCE: Upper Eocene: Browns Creek Clays, SW. Victoria, greensand, carbonaceous clay 25 ft below greensand and calcareous clay 15 ft above greensand.

DESCRIPTION: Shell small, oval, without a horn, tabulated, and divided equally by a relatively broad, helicoid girdle consisting of six plates. Plates smooth or

faintly granular, bordered by transparent ledges. The longitudinal field on the ventral surface (representative of a longitudinal furrow), which extends from the apical plates to the antapical plate, is typically marked by three large plates; very occasionally the transverse wall between the two upper ones is incomplete. Archeopyle formed by the removal of plate 3".

TABULATION: 3-4', 6", 6g, 5"', 1p, 1''''.

DIMENSIONS: Holotype—62 μ long, 57 μ wide. Range—55-80 μ long, 48-86 μ wide.

COMMENT: *L. dispertitum* closely resembles *L. maculatum* Cookson & Eisenack (1961) from Upper Eocene deposits in Rottnest Is., Western Australia. It is distinct from this species in that the surfaces of the plates are smooth or only faintly granular, not 'distinctly dotted' as in *L. maculatum* and the longitudinal field is usually divided, not continuous and furrow-like as in that species.

Leptodinium victorianum n.sp.

(Pl. 12, fig. 8, 9; holotype P24099)

AGE AND OCCURRENCE: Upper Eocene: Browns Creek Clays, SW. Victoria, greensand, calcareous clay 15 ft above greensand.

DESCRIPTION: Shell nearly spherical, clearly tabulated, borders of plates, including those of girdle distinct, thin and transparent. Girdle strongly helicoid, represented by six plates, the lower borders of the two plates adjacent to the longitudinal field usually missing. Longitudinal field partially divided into three plates, the two upper ones always incompletely separated, the third adjacent to plate 1'''' clearly delimited. Archeopyle formed by the detachment of plate 3".

TABULATION: 3', 6", 5"', 1p, 1''''.

DIMENSIONS: Holotype—overall length 100 μ , overall width 100 μ . Range—overall length 80-120 μ , overall width 80-123 μ .

COMMENT: At first sight *L. victorianum* appears very similar to *L. dispertitum*. The main distinguishing features are the larger size, spherical form, and the constant absence of the transverse dividing between the upper two plates of the ventral field in *L. victorianum*. This species differs from *L. maculatum* from Western Australia in having a smooth surface and in the constant presence of a clearly defined plate adjacent to the antapical plate.

Leptodinium elegans n.sp.

(P. 12, fig. 10-13; holotype fig. 10, 12, P24100)

AGE AND OCCURRENCE: Upper Eocene: Browns Creek Clays, SW. Victoria, calcareous clay 15 ft above greensand.

DESCRIPTION: Shell spherical, thick-walled (c. 3-5 μ), girdle equatorial, strongly helicoid, clearly defined and plated on the dorsal surface, only slightly so on the ventral surface. Borders of plates including those of girdle, high, transparent, and granular with wavy or dotted edges. The longitudinal field wide and only partially plated and bordered. The plate adjacent to the antapex is always present as is the right-hand border of the field; the left-hand border is restricted to the hypotheca. The archeopyle is formed by the detachment of a portion of plate 3". Wall of shell finely and densely granular.

TABULATION: 3', 6", 5"', 1p, 1''''.

DIMENSIONS: Holotype—overall length *c.* 100 μ , overall width *c.* 100 μ ; shell 70 \times 70 μ . Range—overall length *c.* 80-120 μ , overall width *c.* 80-123 μ ; shell 67-81 \times 67-86 μ .

COMMENT: *L. elegans* is readily distinguishable from *L. dispertitum*, *L. victorianum*, and *L. maculatum* from Western Australia by the high and characteristically featured borders of the plates. In addition, it differs from all three in the restriction of the border of the longitudinal field to the hypotheca.

Family MICRODINIACEAE

Genus **Eisenackia** Deflandre & Cookson

Eisenackia ornata n.sp.

(Pl. 13, fig. 1-8; holotype fig. 1, 2, P24101)

AGE AND OCCURRENCE: Upper Eocene: Browns Creek Clays, SW. Victoria, from carbonaceous clay 25 ft below greensand to gritty clay 50 ft above greensand inclusive.

DESCRIPTION: Shell oval, apex slightly pointed, antapex with two short projections, girdle equatorial, broad, strongly helicoid, divided into six plates. Dorsal surface clearly tabulated, the plates which are outlined by low, transparent ledges (Pl. 13, fig. 8) being separated by distinct furrows. The ventral field, corresponding to the longitudinal furrow, is broadly oval and crossed by a varying number of irregularly arranged straight or curved low, narrow ridges of different lengths. The two antapical projections are situated at the ventral corners of the antapical plate. The surface of the shell is rather finely and closely granular. The shell opens by the detachment of a slightly hexagonal apical operculum (Pl. 13, fig. 7).

TABULATION: 4', 5" (or 6"), 5"', 2p, 1''''.

DIMENSIONS: Holotype—70 μ long, 57 μ wide; paratype 67 \times 56 μ . Range—width 55-88 μ .

COMMENT: Of the many examples of *E. ornata* seen, only two (holotype and unfigured paratype) have been complete. Those from which the operculum has been detached expand tangentially to varying degrees, so that the measurement of width given (53-88 μ) is not necessarily a true one.

E. ornata is clearly distinguishable from the genotype *E. crassitabulata* Deflandre & Cookson (1955) by the granular surface pattern in contrast to the thick-walled reticulum of *E. crassitabulata* and by the unplated and distinctive character of its ventral field.

The specimen from an Upper Paleocene deposit in N. Germany referred by Alberti (1961, Pl. 3, fig. 19) to *E. crassitabulata*, seems more like *E. ornata*, as far as can be judged from a ventral view alone. Alberti states that the surface-pattern is only faintly indicated whereas, in all the examples of *E. crassitabulata* that we have seen, the reticulum with relatively wide muri has been clearly discernible (Cookson & Eisenack 1965a). On the other hand, the granulation of *E. ornata* could be more difficult to see were the preservation to be unfavourable.

Family STEPHODINIACEAE

Genus **Stephodium** Deflandre

Stephodium spiniferum n.sp.

(Pl. 14, fig. 10; holotype, P24105)

AGE AND OCCURRENCE: Browns Creek Clays, SW. Victoria, carboniferous clay 25 ft below greensand, carbonaceous clay 40 ft above greensand.

DESCRIPTION: Shell with the two prominent equatorial wing-like flanges characteristic of the genus. The flanges are crossed by fine ledges which radiate from the shell. The margins of the flanges are undulant and their convexities ornamented with spinous outgrowths. A ventral opening is present, in the vicinity of which are a few larger spines.

DIMENSIONS: Holotype—c. 64 μ across the wing. Range—c. 56-64 μ .

COMMENT: Six specimens have been recovered, all of which are considerably flattened, making details regarding the shell and measurements difficult to obtain. However, all are considerably smaller than *Stephodinium australicum* Cookson & Eisenack 1962 from mid-Cretaceous deposits in Western Australia. *S. spiniferum* differs from this species, as well as from the two European Cretaceous species *S. coronatum* Deflandre and *S. europaecum* Cookson & Hughes 1964, in the presence of the spine-like outgrowths.

Family Uncertain

Genus *Schmatophora* Deflandre & Cookson

COMMENT: When the genus *Schmatophora* was first described, the authors stated that 'more and better preserved examples are needed to establish the exact tabulation necessary for the recognition of the affinities and systematic position of *Schmatophora*'. For this reason we are including a few additional details obtained from a study of specimens from Browns Ck that are referable to the genotype *S. speciosa*.

Schmatophora speciosa Deflandre & Cookson

(Pl. 13, fig. 9-12)

Systematophora speciosa Deflandre & Cookson 1955, 4: 262.

AGE AND OCCURRENCE: Upper Eocene: Browns Ck, calcareous clay 15 ft above greensand.

COMMENT: In the specimens from Browns Ck, as in the refigured paratype (Pl. 13, fig. 9, 10), a helicoid girdle composed of rectangular fields is prominent on the dorsal surface and visible near the lateral edges of the ventral surface. There are four apical fields of unequal size, one antapical field and three pre- and postcingular fields (Pl. 13, fig. 11, 12) on the dorsal surface. The smaller fields of the ventral surface are variable in size and number and separated by intercalary strips. The shell opens by an apical archeopyle.

Genus *Hemiplacophora* n.gen.

DESCRIPTION: Shell broadly oval to almost spherical, dorsiventral, the surface divided into field-like areas by incomplete semicircular ledges. The apex has four small fields, two larger dorsal and two very small ventral ones; there is one large antapical field. The dorsal surface is characterized by four large, approximately semicircular fields, the long axes of which are parallel to the long axis of the shell, two immediately beneath the apex and two adjacent to the antapex; the equatorial area is without ledges. On the ventral surface the ledges are irregularly arranged and vary in number and in outline from short to long and from straight to wavy, curved or even almost circular. The ledges have knob-like or much thickened bases and thin, continuous or perforated \pm wing-like expansions with crenulate margins. The shell opens by an apical archeopyle.

GENOTYPE: *Hemiplacophora semilunifera* n.sp.

Hemiplacophora semilunifera n.sp.

(Pl. 14, fig. 4-9, 16; holotype fig. 4, 5, P24103)

AGE AND OCCURRENCE: Upper Eocene: Browns Creek Clays, SW. Victoria, carbonaceous clay 40 ft above greensand.

DESCRIPTION: Shell small, broadly oval with slightly flattened apex and antapex, in one specimen five typical fields have been seen in the 'epitheca' and four or five in the 'hypotheca'. Ledges of the ventral surface usually low, not enclosing fields, very variable as to shape and length, occasionally almost circular in outline. The wing-like expansions of the ledges are variable in width, height, and degree of perforation; they are frequently inconspicuous on the ventral surface. Wall of shell relatively thick, closely and finely granular. The operculum bears two \pm circular ledges and two short straight ones (Pl. 14, fig. 16).

DIMENSIONS: Holotype—overall length c. 62 μ , overall width c. 57 μ ; shell c. 54 \times 50 μ . Range—overall length c. 60-70 μ , overall width c. 56-62 μ .

COMMENT: The present limits purposely allowed for *H. semilunifera* are rather wide. It seems possible, therefore, that further investigations may result in the specific separation of individuals similar to the one shown in Pl. 14, fig. 8, 9.

Genus **Systematophora** Klement**Systematophora ancyrea** n.sp.

(Pl. 14, fig. 1-3; holotype fig. 1, P24102)

AGE AND OCCURRENCE: Upper Eocene: Browns Creek Clays, SW. Victoria, carbonaceous clay 25 ft below greensand, carbonaceous clay 40 ft above greensand.

DESCRIPTION: Shell spherical or slightly oval with a rather thick, densely granular wall and numerous slender, flexuous, simple or occasionally forked appendages with capitate or slightly bifurcate apices. The appendages arise, mainly, from raised ridges which completely or incompletely delimit circular or polygonal areas. These areas are variable in size and are either separate from one another or coalescent. On one surface such areas tend to bound a narrow longitudinal apparently appendage-free surface. The shell opens by an apical archeopyle, the angular rim of which is suggestive of plates.

DIMENSIONS: Holotype—overall width c. 97 μ , width of shell c. 62 μ . Range—overall width c. 86-97 μ , width of shell c. 52-62 μ , appendages c. 10-26 μ .

COMMENT: *S. ancyrea* differs from the Jurassic genotype *S. areolata* Klement in that the boundaries of the fields from which the appendages arise are not always complete, nor always separate from one another. The same differences separate *S. ancyrea* from the Victorian Miocene species *S. (Hytrichosphaeridium) placantha* (Deflandre & Cookson 1955). The figured holotype of this species clearly supports the statement by these authors that 'each field is separated from its neighbours by an area devoid of appendages'.

Genus **Samlandia** Eisenack**Samlandia reticulifera** n.sp.

(Pl. 15, fig. 10-15; holotype fig. 10, P24106)

AGE AND OCCURRENCE: Browns Creek Clays, SW. Victoria, greensand and calcareous clay 15 ft above greensand.

DESCRIPTION: Shell oval with a short, conical, apical and antapical projection and two lower, broader or less clearly defined projections in an equatorial position,

one on each side. Wall of shell 2-layered, the inner ornamented by a complete or incomplete reticulum. The relatively thick muri support short, thin, closely and vertically arranged appendages with broadened apices (Pl. 15, fig. 15) which, by their close approximation and possible coalescence, form the closely opposed outer thin layer of the wall. The archeopyle is sub-apical and the operculum approximately quadrangular or rectangular in outline.

DIMENSIONS: Holotype—*c.* 114 μ long, *c.* 94 μ wide. Range—*c.* 80-114 μ long, *c.* 70-95 μ wide.

COMMENT: *S. reticulifera* differs from the genotype *S. chlamydothora* (Eisenack 1963, Pl. 2, fig. 14) in the prominent reticulation of the inner layer of the wall and the close approximation of the enclosing membrane. In *S. chlamydothora* the outer membrane is widely separated from the inner wall and is supported by long unbranched lamellae. The archeopyle is sub-apical in both species.

Genus *Aireiana* n.gen.

DESCRIPTION: Shell spherical, firm-walled, with an apical and antapical prominence and a number of irregularly distributed wart-like areas of variable size and construction. A smooth girdle-like zone and a similar unornamented longitudinal area may be indicated on the dorsal and ventral surfaces respectively. The shell opens by a sub-apical archeopyle.

COMMENT: The genus is named after the Aire District in SW. Victoria in which the Upper Eocene Browns Creek Clays are situated.

GENOTYPE: *Aireiana verrucosa* n.sp.

Aireiana verrucosa n.sp.

(Pl. 14, fig. 11-13; holotype fig. 11, 12, P24107)

AGE AND OCCURRENCE: Upper Eocene: Browns Creek, SW. Victoria, calcareous clay 15 ft above greensand.

DESCRIPTION: Shell dorsiventral, almost spherical, rather thick-walled (*c.* 3-4 μ) with short apical and antapical prominences. In the type the apical prominence is short (*c.* 5 μ), relatively broad, and concave distally; the antapical one is larger (*c.* 12 μ long), conical, and of fibrillar construction. A few wart-like outgrowths of variable size have occurred on the general surface of all the examples examined, at least some of them being composed of short, straight fibrils, the distal ends of which are united (Pl. 14, fig. 13).

The dorsal surface of the type (Pl. 14, fig. 12) is partially ornamented with dot-like thickenings, a relatively wide, approximately equatorial portion being unornamented. This area, suggestive of a girdle-zone, is partly outlined by two sets of three individual but closely approximated thickenings of characteristic appearance on one side of the mid-line. On the other side, thickenings are also present but they are fewer, smaller, and less regularly arranged.

The ornament of the ventral surface of the type (Pl. 14, fig. 11) consists of short, closely intertwined curved ridges, except in a median longitudinal area in the antapical portion of the shell where the wall is smooth.

The shell opens by a large rounded trapezoid archeopyle.

DIMENSIONS: Holotype—overall length *c.* 95 μ ; shell *c.* 78 μ long, *c.* 76 μ wide. Range—overall length 76-95 μ ; shell *c.* 68-78 μ .

COMMENT: Although several examples of *A. verrucosa* have been recovered,

both the generic and specific descriptions given above have been based mainly on the well-presented specimen taken as the type. The reason for this is that the five other examples in hand are either lying in less suitable planes or are somewhat compressed. However, these additional examples, especially the paratype in which paired thickenings, similar to those delimiting the girdle zone of one side in the type, are present, afford strong support for our action in giving this form generic status.

Several features of *A. verrucosa* suggest a general relationship with the Dinophyceae.

Family HYSTRICHOSPHAERACEAE

Genus **Cannosphaeropsis** O. Wetzell

Cannosphaeropsis cf. **densiradiata** Cookson & Eisenack 1962

(Pl. 14, fig. 15, P24179)

Cannosphaeropsis densiradiata Cookson & Eisenack 1962, p. 493, Pl. 4, fig. 5-7.

AGE AND OCCURRENCE: Upper Eocene: Browns Ck, SW. Victoria, greensand, carbonaceous clay 25 ft below greensand.

COMMENT: Several specimens which closely resemble the Western Australian Cenomanian species *C. densiradiata* have been recovered from the Browns Ck deposits mentioned above. All agree with this species in respect of small size and large number of the fine radial appendages, from the distal branching and subsequent fusion of which the enclosing open network is derived.

In the Browns Ck examples the number of appendages, and to some extent their shape, has varied somewhat. In those with fewer and wider appendages the loops comprising the network are correspondingly larger than, for example, the one figured (Pl. 14, fig. 15) in which they are very fine, numerous, and closely approximated. Until more is known, therefore, regarding the variation that may occur in specimens of *C. densiradiata* from the type locality, we prefer to compare the Victorian Tertiary specimens with rather than assign them to this species.

Of local interest is the recent recognition of specimens similar to those from Browns Ck in a sample from the Nelson Bore, SW. Victoria at 730 ft.

DIMENSIONS: Range—overall diameter of Browns Ck examples c. 52-83 μ ; diameter of shell 28-48 μ .

Family HYSTRICHOSPHAERIDIACEAE

Genus **Cordosphaeridium** Eisenack

Cordosphaeridium capricornum n.sp.

(Pl. 15, fig. 1-9; holotype fig. 7, P24104)

AGE AND OCCURRENCE: Upper Eocene: Browns Creek Clays, SW. Victoria, greensand to gritty clay 50 ft above greensand inclusive.

DESCRIPTION: Shell approximately spherical with numerous radially arranged appendages of characteristic form which vary in number in individual specimens and in size, form, and structure in one and the same specimen. All are solid; some are simple with unbranched or slightly branched apices or with terminal bifurcations which extend laterally and are upwardly or downwardly curved; others are broadly flattened and perforated to varying degrees with broad apices which narrow gradually as they curve backwards towards the shell. The upper surface of the apices and their extensions are consistently finely denticulate (Pl. 15, fig. 8, 9). The bases of the larger appendages are semicircular to, occasionally, almost circular,

and similarly the tips of the apical prolongations sometimes appear to touch but, in reality, are never connected. The appendages are sometimes faintly and longitudinally striated; shorter and more pronounced striations may be evident at or near their points of origin. The surface of the shell is faintly granular.

The archeopyle is apical, the operculum bearing four appendages, two relatively large and two small (Pl. 15, fig. 9).

At the antapex an approximately circular area, outlined either completely (Pl. 15, fig. 6) or incompletely by a ridge to which a few small simple appendages may or may not be attached, has been seen. Such an area is suggestive of an antapical field.

DIMENSIONS: Holotype—overall width *c.* 78 μ , width of shell *c.* 52 μ . Range—overall width *c.* 70-94 μ , width of shell *c.* 43-52 μ ; appendages *c.* 18-30 μ long.

COMMENT: In the holotype the distribution of the appendages on the two surfaces differs. On the one shown in Pl. 15, fig. 7 there is a relatively large appendage-free area, whereas on the other surface the appendages are more evenly distributed. In the paratype (Pl. 15, fig. 2, 3) an almost circular antapical ridge supports a number of long thread-like appendages, the broadened apices of which unite to form an almost complete distal ring. At present the significance and constancy of such features cannot be estimated. *C. capricornum* is one of the most frequent forms in the greensand and higher deposits in the Browns Creek section.

Genus *Hystrichokolpoma* Klumpp

Hystrichokolpoma rigaudae Deflandre & Cookson 1955

(Pl. 13, fig. 13, 14)

Hystrichokolpoma rigaudae Deflandre & Cookson 1955, p. 279, Pl. 6, fig. 6, 10, Fig. 42.

Hystrichokolpoma rigaudae Deflandre & Cookson; Maier 1959, p. 311, Pl. 31, fig. 2.

Hystrichokolpoma rigaudae Deflandre & Cookson; Gerlach 1961, p. 183, Pl. 27; fig. 8, 9.

Hystrichokolpoma rigaudae Deflandre & Cookson; Rossignol 1964, p. 89, Pl. 2, fig. 5, Pl. 3, fig. 8.

AGE AND OCCURRENCE: Upper Eocene: Browns Creek Clays, greensand, calcareous clay 15 ft above greensand. Carbonaceous clay about 40 ft above greensand, gritty clay 45-50 ft above greensand.

COMMENT: This species was originally described from Victorian deposits that ranged from Upper Paleocene (Princetown Member of Dilwyn Clay) to Upper Eocene. The particularly well-preserved example illustrated herein is of special interest since it demonstrates that some, at least, of the plate-like areas do not represent 'the bases of the larger processes . . . that give the impression of plates' (Deflandre & Cookson 1955, p. 280). Two of these plate-like areas are situated immediately beneath the edge of the archeopyle, the angular character of which supports the inference that apical plates had been present (Pl. 13, fig. 13). Smaller areas with wavy outlines are associated with small equatorially-placed processes (Pl. 13, fig. 14).

ACRITARCHA Evitt

Subgroup ACANTHOMORPHITAE Downie, Evitt & Sarjeant

Genus *Baltisphaeridium* Eisenack

Baltisphaeridium sp.

(Pl. 14, fig. 14)

AGE AND OCCURRENCE: Upper Eocene: Browns Creek Clays, SW. Victoria, calcareous clay 15 ft above greensand.

DESCRIPTION: Shell relatively small, spherical with numerous fine, unbranched appendages of variable number and size, their length not exceeding that of the radius of the shell. In one example P24108 a small circular opening *c.* 6 μ in diameter is clearly outlined.

DIMENSIONS: Figured specimen, overall diameter *c.* 62 μ . Range—overall diameter *c.* 62-72 μ , diameter of shell *c.* 41-48 μ ; appendages *c.* 10-15 μ .

COMMENT: This form seems to be closest to the Victorian Tertiary species *B. machaeophorum* (Deflandre & Cookson), especially when taken in the broad sense adopted by certain authors (Brosius 1963, Pl. 7, fig. 5; Rossignol 1964, Pl. 3, fig. 20) in neither of whose figures do the appendages appear to be 'dagger'-like as in the original description.

The occurrence of a small circular opening similar to the one occurring in *Baltisphaeridium nanum* Cookson (1965, Pl. 10, fig. 9) is of special interest.

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Explanation of Plates

PLATE 11

- Fig. 1-5—*Peridinium eocenicum* n.sp. Browns Creek greensand, 1, 2, ventral and dorsal surfaces of holotype \times c. 800; 3, dorsal surface of another example showing archeopyle \times c. 800; 4, 5, ventral and dorsal surfaces of paratype, P24086 \times c. 800.
- Fig. 6, 7—*Deflandrea leptodermata* n.sp. 6, holotype, Browns Ck, carbonaceous clay 25 ft below greensand \times c. 600; 7, paratype, P24094, greensand \times c. 600.
- Fig. 8, 9—*Deflandrea granulosa* n.sp. Browns Ck, gritty clay 45-50 ft above greensand, 8, holotype \times c. 600; 9, paratype, P24096 \times c. 500.
- Fig. 10—*Deflandrea* cf. *heterophlycta* Deflandre & Cookson. Browns Ck, calcareous clay 15 ft above greensand \times c. 600.
- Fig. 11—*Deflandrea phosphoriica* Eisenack. Browns Ck, carbonaceous clay 40 ft above greensand \times c. 400.

PLATE 12

- Fig. 1-4—*Deflandrea heterophlycta* Deflandre & Cookson. Castle Cove, Victoria, 1, 2, ventral and dorsal surfaces of the same example \times c. 600; 3, 4, ventral and dorsal surfaces of a free capsule \times c. 600.
- Fig. 5-7—*Leptodinium dispertitum* n.sp. Browns Ck, carbonaceous clay 25 ft below greensand; 5, 6, ventral and dorsal surfaces of holotype \times c. 600; 7, ventral surface of paratype P24098 \times c. 600.
- Fig. 8, 9—*Leptodinium victorianum* n.sp. Browns Ck greensand, ventral and dorsal surface of holotype \times c. 600.
- Fig. 10-13—*Leptodinium elegans* n.sp. Browns Ck, calcareous clay 15 ft above greensand; 10, 12, dorsal and ventral surfaces of holotype \times c. 400; 11, 13, dorsal and ventral surfaces respectively of two additional examples \times c. 400.

PLATE 13

- Fig. 1-8—*Eisenackia ornata* n.sp. Browns Ck, carbonaceous clay 25 ft below greensand; 1, 2, ventral and dorsal surfaces of holotype \times c. 500; 3, 5, ventral surfaces of two examples from greensand \times c. 600; 4, apical view after removal of operculum of a specimen from greensand \times c. 500; 6, dorsal surface of example from carbonaceous clay 25 ft below greensand \times c. 600; 7, detached operculum \times c. 600; 8, ledge of a field \times c. 1000.
- Fig. 9-12—*Schematophora speciosa* Deflandre & Cookson. 9, 10, ventral and dorsal surfaces of refigured paratype, P16298 (Deflandre & Cookson Pl. 6, fig. 13) \times c. 800; 11, 12, ventral and dorsal surfaces of an example from Browns Ck, calcareous clay 15 ft above greensand \times c. 900.
- Fig. 13, 14—*Hystrichokolpoma rigaudae* Deflandre & Cookson. Browns Ck, carbonaceous clay 40 ft above greensand, two views of the same specimen \times c. 600.
- Fig. 15—*Scriniodinium australiense* (Deflandre & Cookson). Browns Ck, carbonaceous clay 25 ft below greensand \times c. 600.

PLATE 14

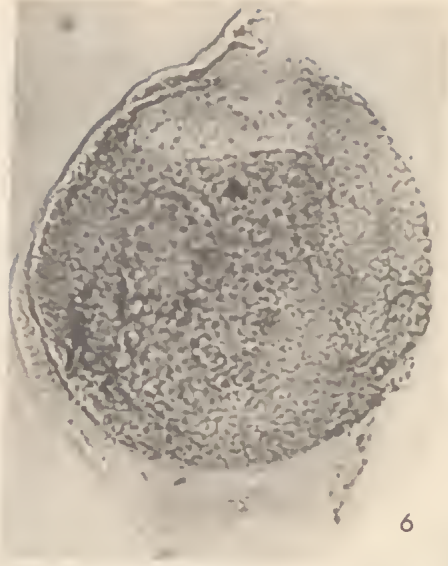
- Fig. 1-3—*Systematophora ancyrea* n.sp. Browns Creek greensand. 1, holotype \times c. 600; 2, 3 \times c. 600.
- Fig. 4-9, 16—*Hemiplacophora semilunifera* n.sp. Browns Ck, carbonaceous clay c. 40 ft above greensand. 4, 5, ventral and dorsal surfaces of holotype \times c. 600; 6, 7, ventral and dorsal surfaces of paratype \times c. 600; 8, 9, ventral and dorsal surfaces of another example \times c. 800; 16, operculum \times c. 600, P24177.
- Fig. 10—*Stephodinium spiniferum* n.sp. Browns Ck, carboniferous clay c. 40 ft above greensand. Holotype \times c. 800.
- Fig. 11-13—*Aireiana verrucosa* n.sp. Browns Ck, calcareous clay 15 ft above greensand. 11, 12, holotype \times c. 400; 13, a surface ornament \times c. 400.
- Fig. 14—*Baltisphaeridium* sp. Browns Ck, calcareous clay \times c. 600.
- Fig. 15—*Cannosphaeropsis* cf. *densiradiata*. Browns Ck, carbonaceous clay 25 ft below greensand \times c. 600, P24179.

PLATE 15

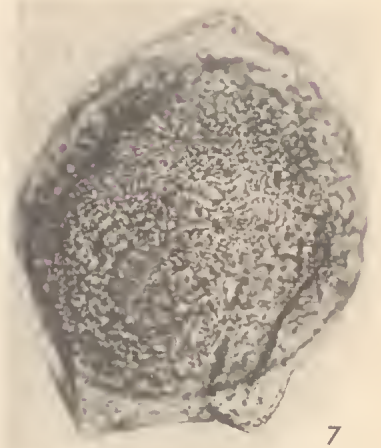
- Fig. 1-9—*Cordosphaeridium capricornum* n.sp. Browns Ck, carbonaceous clay 40 ft above greensand. 1-7, \times c. 600; 2, 3, paratype P24176; 7, holotype; 8, portion of shell showing details of appendages \times c. 600; 9, operculum \times c. 600.
- Fig. 10-15—*Samlandia reticulifera* n.sp. Browns Creek greensand. 10, holotype \times c. 400; 11, \times c. 600; 12, paratype P24175 \times c. 400; 13, 14, two opercula \times c. 800; 15, optical section of wall \times c. 800.



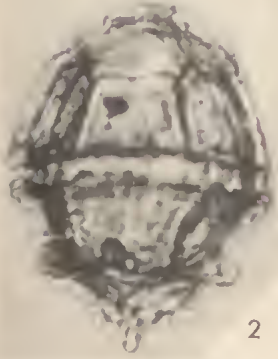
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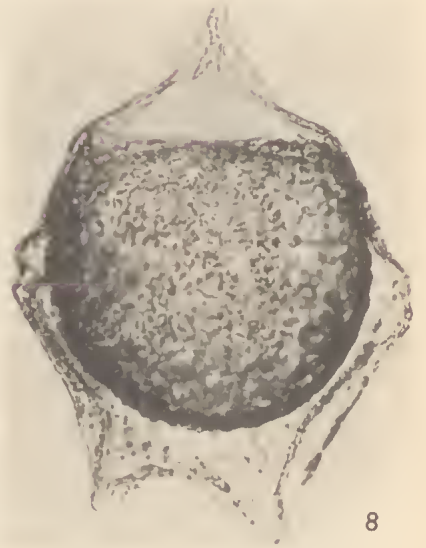
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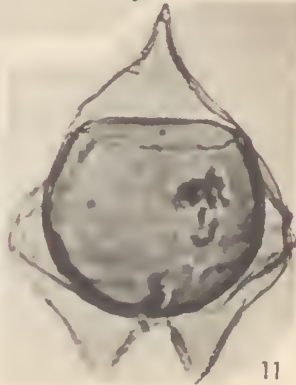
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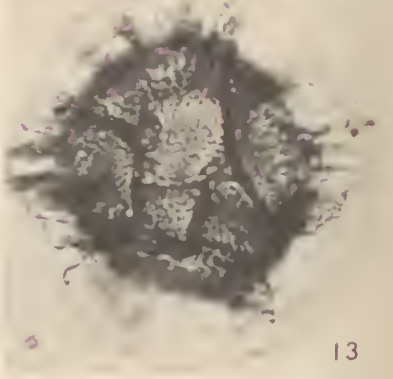
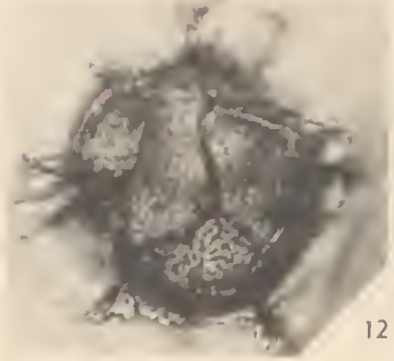
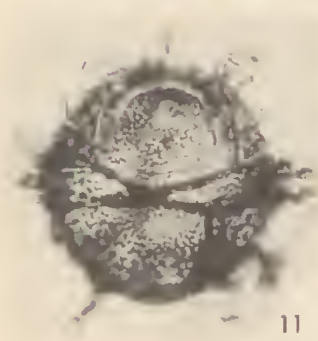
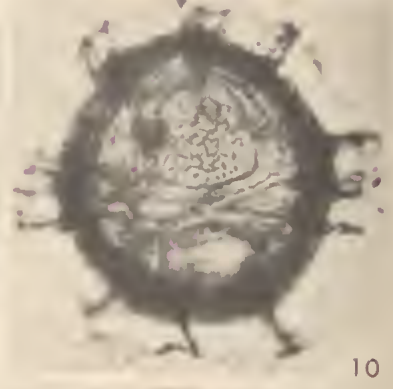
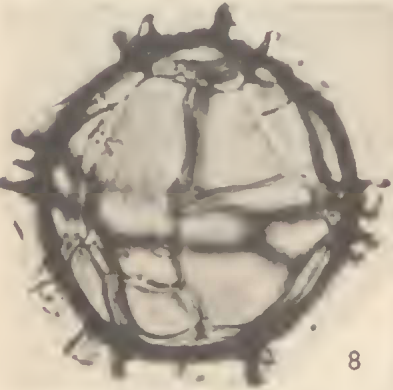
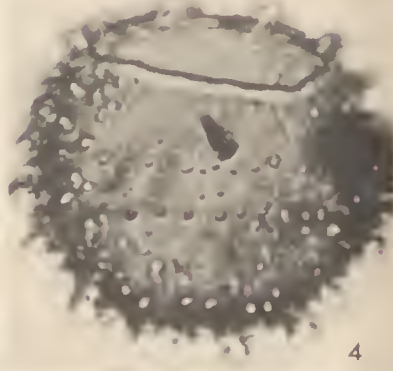
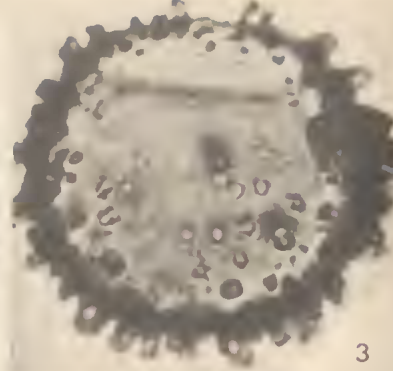
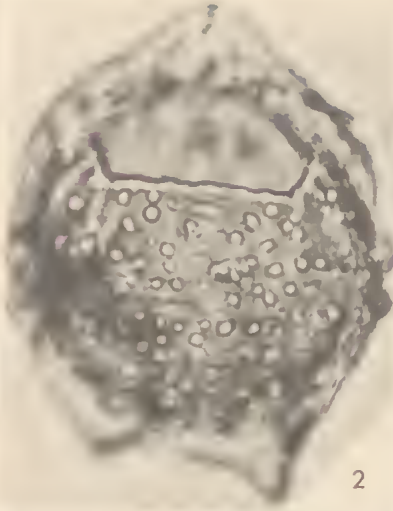
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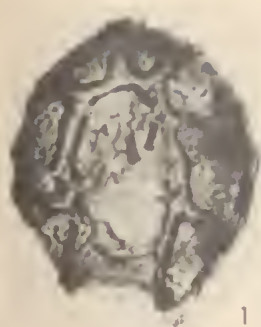


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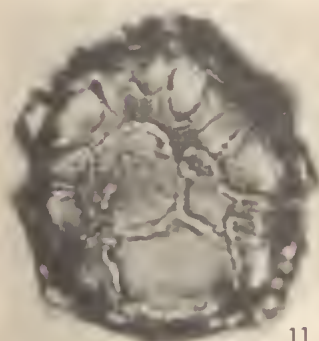
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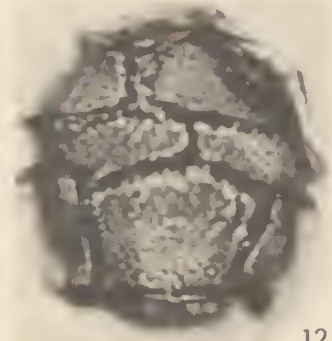
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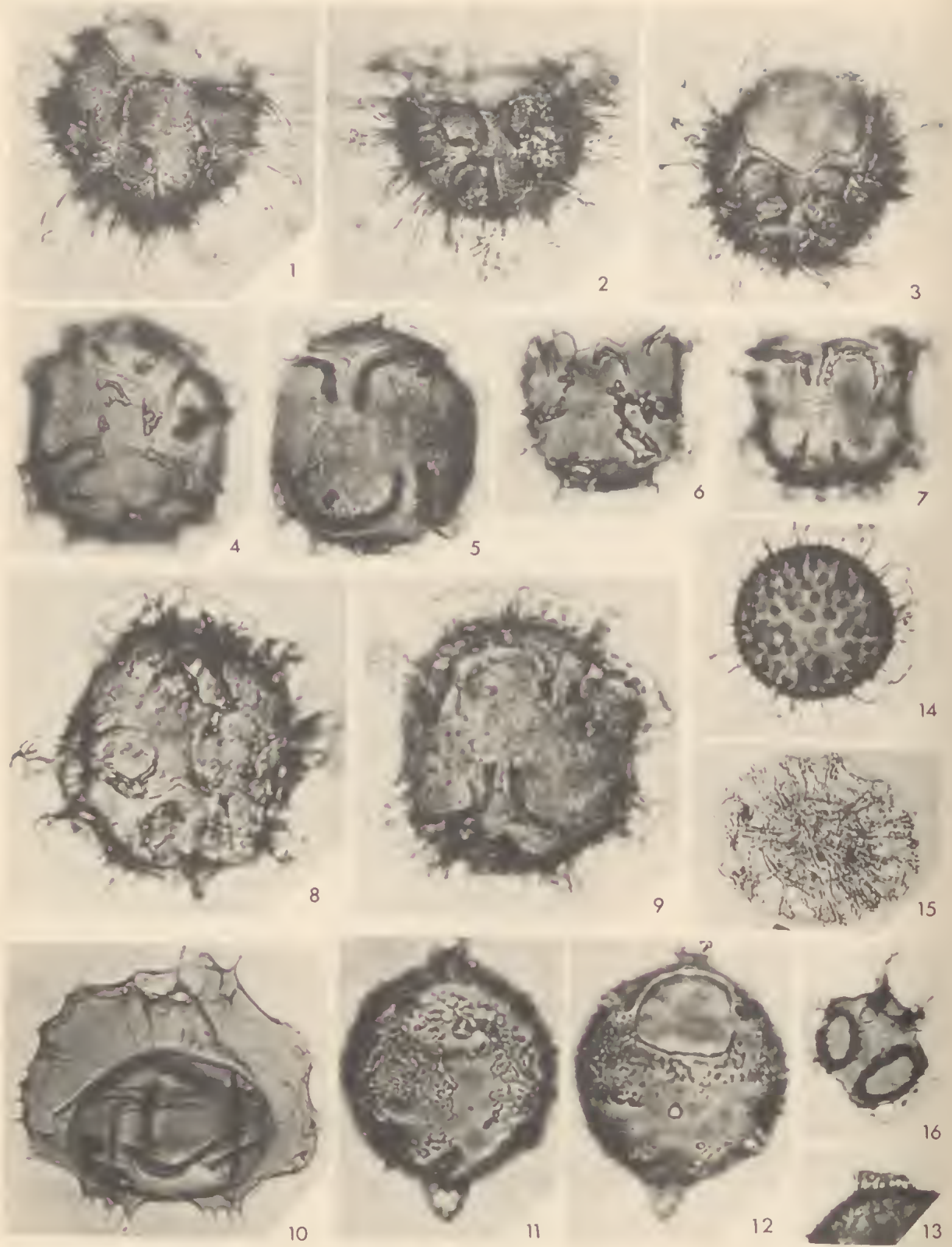
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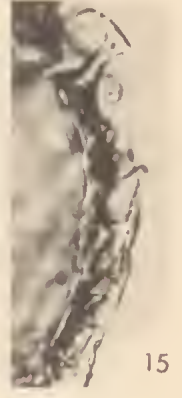
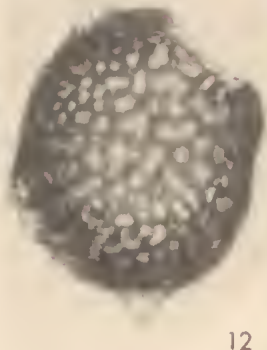
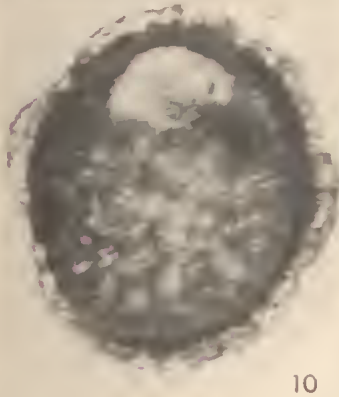
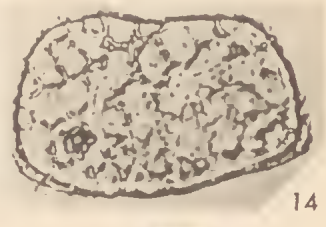
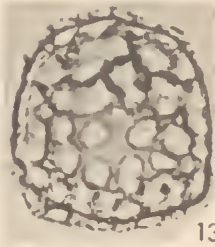
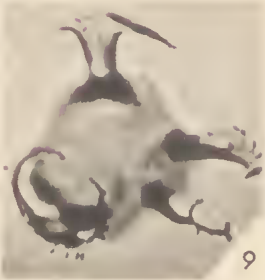
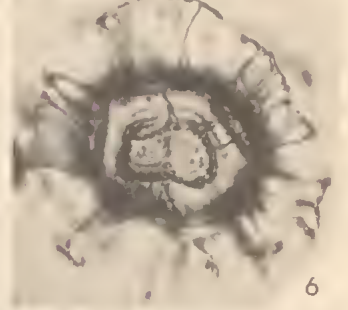
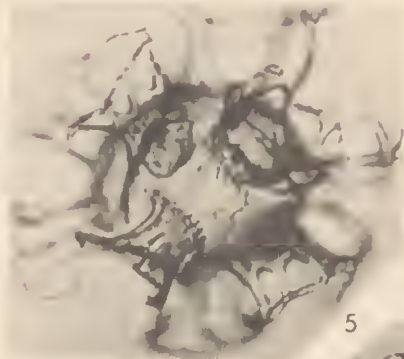
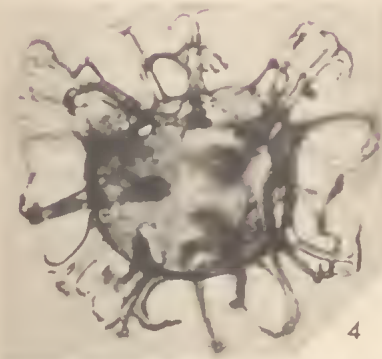
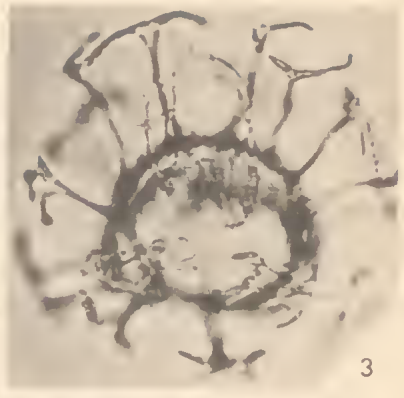
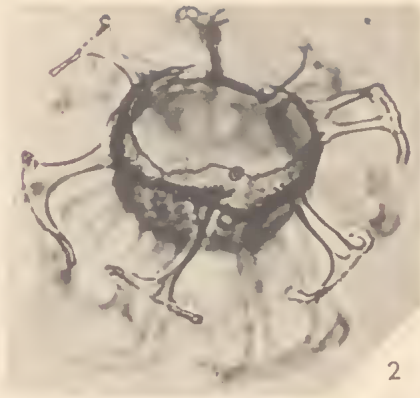
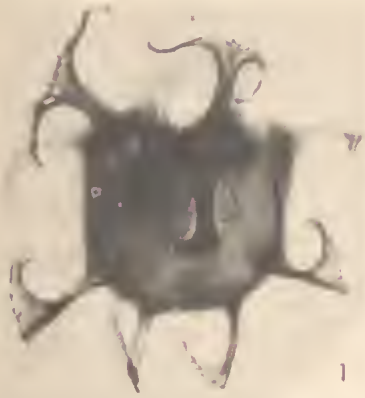


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MICROPLANKTON FROM THE DARTMOOR FORMATION, SW. VICTORIA

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and A. EISENACK

University of Tübingen

Abstract

One new genus and 6 new species of microplankton from the Paleocene Dartmoor Formation in SW. Victoria are described.

Introduction

The present paper is concerned with a small but characteristic microplankton assemblage recovered from a sample of carbonaceous mudstone. This sample was collected by Mr P. R. Kenley (Mines Department of Victoria) from the N. bank of the Glencg R., SE. corner of the Parish of Drajurk, 9 miles SW. of Casterton, SW. Victoria.

Stratigraphically the sample is near the base of the Dartmoor Formation and contains Paleocene Foraminifera (unpublished determination by D. J. Taylor, Mines Department of Victoria). The Dartmoor Formation overlies the Paleocene Bahgallah Formation, which is rock and time equivalent of the Pebble Point Formation exposed near Princetown, which is some 120 miles E. of Casterton. Directly above the Pebble Point Formation is the Dilwyn Clay with the Rivernook Member near its base. Therefore, it can be assumed that the Dartmoor Formation sample is from an equivalent stratigraphic position to the Rivernook Member. It is of interest that the new species, *Baltisphaeridium taylori*, is here described from both the Dartmoor Formation sample and a Rivernook Member sample ('Rivernook sample A' of D. J. Taylor in manuscript).

Systematic Descriptions

Class DINOPHYCEAE

Family DEFLANDREACEAE Eisenack

Genus *Deflandrea* Eisenack 1938

Deflandrea dartmooria n.sp.

(Fig. 1; Pl. 16, fig. 1, 2; holotype, P24080)

AGE AND OCCURRENCE: Paleocene: Dartmoor Formation sample.

DESCRIPTION: Shells rather flat, nearly twice as long as broad and well tabulated, the surfaces of the plates ornamented with small dot-like thickenings. Epitheca longer than hypotheca, triangular in outline gradually narrowing to a well-developed, bluntly-pointed horn. Hypotheca with almost parallel sides, a concave base and two well-developed pointed horns. Girdle distinct, slightly helicoid with finely denticulate edges. Longitudinal furrow broad, nearly straight-sided, its borders sometimes extending almost to the tips of the antapical horns.

In the middle of the furrow the concavo-convex thickening in the vicinity of the flagella-pore, noted as occurring in three other Australian species of Dinophyceae (Cookson & Eisenack 1965), is always conspicuous.

The tabulation, although always present, is not completely identifiable. The apical horn appears to be formed by four long apical plates beneath which are intercalary plates of which the largest, 2^a , forms the hexagonal, precingular archeopyle. The precingular plates number six or possibly seven with $4''$ a broad plate in the middle of the dorsal surface. The postcingular plates are five or possibly six with $3'''$ strongly developed. The antapical plates $1''''$ and $2''''$ are restricted to the lower halves of the antapical horns. Thus the approximation arrived at is $4'$, 4^a , 6 (or 7)'', 5 (or 6)''', $2''''$ (Fig. 1). The sutures are made by clean breaks, fine lines on the ventral surface of the epitheca, or by small dot-like thickenings as at the borders of the antapical horns.

DIMENSIONS: Holotype—c. 152μ long, 80μ broad; capsule c. $62 \times 68 \mu$. Range—c. $119-152 \mu$ long, c. $79-95 \mu$ broad.

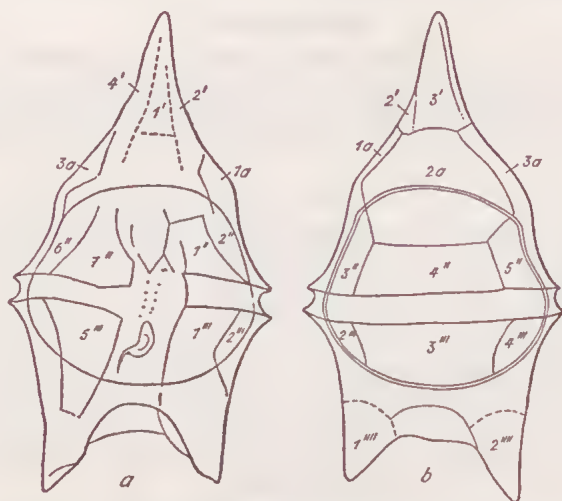


FIG. 1—*Deslandrea dartmooria* Cookson & Eisenack. Dartmoor Formation, Victoria. Ventral and dorsal surfaces \times c. 400.

Genus *Wetzeliella* Eisenack 1938

Wetzeliella hyperacantha n.sp.

(Pl. 16, fig. 3-6; holotype fig. 5, P24087)

AGE AND OCCURRENCE: Paleocene: Dartmoor Formation sample.

DESCRIPTION: Shell flat with approximately straight to convex sides and well-developed apical, antapical and lateral projections or horns, the lateral being the most conspicuous. The wall of shell thin and well-covered with simple or occasionally branched appendages, the apices of which are bluntly pointed, capitate or slightly bifurcate. The apical horn is short and blunt with 2 or 3 divergent, branched or unbranched appendages at its apex. The antapical horn varies in length but, as in the holotype (Pl. 16, fig. 5), is usually long and narrowed to a

blunt tip. The lateral horns are covered with appendages similar to those on the general surface.

The capsule is circular to oval in outline and practically fills the shell. The archeopyle, which develops just below the apex, is small and rounded to slightly angular in outline.

DIMENSIONS: Holotype—*c.* 110 μ long, *c.* 110 μ broad; capsule *c.* 69 \times 64 μ . Range—*c.* 80-110 μ long, *c.* 85-110 μ broad; capsule *c.* 50-69 μ long, *c.* 56-69 μ broad.

COMMENT: Of the previously described species of *Wetzeliella*, *W. hyperantha* approaches most closely to *W. symmetrica* Weiler (1956). The main features which distinguish it from this species are its consistently smaller size, the greater prominence of the lateral horns, the smaller and more numerous appendages, and the shape of the archeopyle.

Family HYSTRICHOSPHAERIDIACEAE

Genus *Cordosphaeridium* Eisenack 1963

Cordosphaeridium bipolare n.sp.

(Pl. 16, fig. 7, 8; holotype fig. 8, P24081)

AGE AND OCCURRENCE: Paleocene: Dartmoor Formation sample.

DESCRIPTION: Shell typically oval, well-covered with narrow, solid, unbranched appendages of varying length and width. Usually the appendages narrow somewhat from broadish bases to widen distally to shallow funnel-shaped apices, the recurved edges of which may bear minute hair-like branches. In the larger appendages fine, longitudinal fibrils may be seen. The shell is bipolar, being characterized by the development of a distinctive apical and antapical appendage. The apical appendage is relatively short and broad, solid, densely granular and with a bluntish tip. It may be simple or with one or two short, slender, lateral branches. In the type specimen (Pl. 16, fig. 8) it appears to be connected with three broad, flattened, longitudinally striated appendages. The antapical appendage is longer than the neighbouring ones, unstriated, unbranched with approximately straight sides and a pointed tip.

The surface of the shell is densely granular with a linear arrangement evident near the bases of the appendages. A large archeopyle extends from close to the apical pole to the equatorial region of one surface.

DIMENSIONS: Holotype—overall length *c.* 128 μ , overall width *c.* 90 μ ; shell *c.* 80 \times 62 μ ; apical appendage *c.* 17 μ long, antapical appendage *c.* 29 μ long. Range—overall length *c.* 124-128 μ , overall width *c.* 88-98 μ ; shell *c.* 80-90 μ \times *c.* 57-70 μ ; apical appendage *c.* 12-17 μ long, antapical appendage *c.* 20-33 μ long.

COMMENT: *C. bipolare* agrees closely with *C. axiale* Eisenack (1965) from an Upper Eocene deposit in East Prussia. It differs, however, from this species in the constant development of a prominent antapical appendage and in the shape and size of the apical appendage.

Family Uncertain

Genus *Kenleyia* n.gen.

DESCRIPTION: Shell small, apparently untabulated, oval to almost circular in outline, usually equally divided by a more or less clearly defined girdle and with one to three solid projections at and adjacent to both apex and antapex of which, when all three are present, the middle one is the most prominent.

Shell wall 2-layered, the inner layer thin and homogeneous, the outer of variable width and construction, from densely or loosely granular to finely lace-like or fibrillose. The apical and antapical projections or horns, and those indicating the lateral position of the girdle, when evident, are derived from this layer. The archeopyle is large and extends from just behind the apex of the dorsal surface to the girdle.

COMMENT: The simple forms of this genus show a certain similarity in shape to that of species of *Gonyaulax*. The genus has been named after Mr P. R. Kenley, Mines Department of Victoria, who kindly donated the Dartmoor Formation sample upon which the present study has been based and in which this genus is so well represented.

GENOTYPE: *Kenleyia pachycerata* n.sp.

***Kenleyia pachycerata* n.sp.**

(Pl. 17, fig. 1-3; holotype fig. 3, P24089)

AGE AND OCCURRENCE: Dartmoor Formation sample.

DESCRIPTION: Shell oval or nearly circular in outline, usually flattened; apical and antapical horns and the two smaller projections, one on either side of them, short, broadish and blunt. Girdle frequently clearly outlined. Wall of shell thick, the outer layer closely granular. Archeopyle prominent in favourably presented examples, trapezoid.

DIMENSIONS: Holotype—overall length c. 94 μ , overall width c. 90 μ ; shell c. 80 \times 76 μ . Range—overall length c. 85-102 μ , overall width c. 70-76 μ .

***Kenleyia leptocerata* n.sp.**

(Pl. 17, fig. 5, 6; holotype, P24088)

AGE AND OCCURRENCE: Dartmoor Formation sample.

DESCRIPTION: Shell oval, thin-walled, outer layer finely granular, girdle equatorial bordered by low, fibrillose ledges; apical horn short, broadish and blunt, antapical horn longer, tapering from base to apex, tip frequently upwardly curved. Accessory apical outgrowths clear in the holotype (Pl. 17, fig. 6) more often poorly developed or fibrillose as also are those of the antapex; fibrillose outgrowths may be present on other portions of the shell. Archeopyle large, trapezoid, straight-sided, extending from just behind the apex almost to the girdle.

DIMENSIONS: Holotype—overall length c. 102 μ , overall width c. 76 μ ; shell c. 78 \times 62 μ . Range—overall length c. 100-112 μ , overall width c. 76-85 μ ; shell c. 70-82 $\mu \times$ 62-75 μ ; antapical horn c. 22 μ long.

***Kenleyia lophophora* n.sp.**

(Pl. 17, fig. 7-10; holotype fig. 8, P24092)

AGE AND OCCURRENCE: Dartmoor Formation sample.

DESCRIPTION: Shell oval to almost circular in outline with apical and antapical horns, an equatorial girdle and large archeopyle. Shell wall 2-layered, the outer layer varying both in extent and structure, being either shortly fibrillose with \pm well-developed tuft-like prominences, especially on either side of the apical and antapical horns and lateral limits of the girdle (Pl. 17, fig. 8), or in the form of lace-like expansions of varying widths (Pl. 17, fig. 10). The apical horn narrows distally to a blunt tip; the antapical horn, which is longer, is usually straight-sided with a blunt tip.

DIMENSIONS: Holotype—overall length *c.* 117 μ , overall width *c.* 100 μ ; shell *c.* 68 \times 72 μ . Range—overall length *c.* 100-108 μ , overall width *c.* 62-72 μ ; antapical horn *c.* 22 μ .

INCERTAE SEDIS

ACRITARCHA Evitt

Subgroup ACANTHOMORPHITAE Downie, Evitt & Sarjeant

Genus *Baltisphaeridium* Eisenack 1958

Baltisphaeridium taylori n.sp.

(Pl. 16, fig. 9-11; holotype fig. 10, P24083)

AGE AND OCCURRENCE: Paleocene: Base of Rivernook Member of Dilwyn Clay, SW. Victoria. Dartmoor Formation sample.

DESCRIPTION: Shell typically circular in outline, frequently oval as result of distortion, relatively thick-walled with short, well-spaced, broadly-based, solid appendages which narrow towards bluntish or pointed apices. The appendages are straight or variously curved. The wall of the shell is granular and appears to be 2-layered since the granules are slightly elongate and closely and vertically arranged on the thin homogeneous shell wall.

DIMENSIONS: Holotype—overall *c.* 63 \times 58 μ ; shell *c.* 50 \times 48 μ ; appendages *c.* 8 μ long; wall *c.* 1.5-1.8 μ thick. Range—overall *c.* 50-67 μ ; shell *c.* 36-50 μ ; appendages *c.* 5-9 μ long.

COMMENT: *B. taylori* differs from the Cretaceous species *B. granulatum* (Deflandre 1937) in the shape of the shell and length and shape of the appendages. The species is named after Mr D. J. Taylor of the Mines Department of Victoria.

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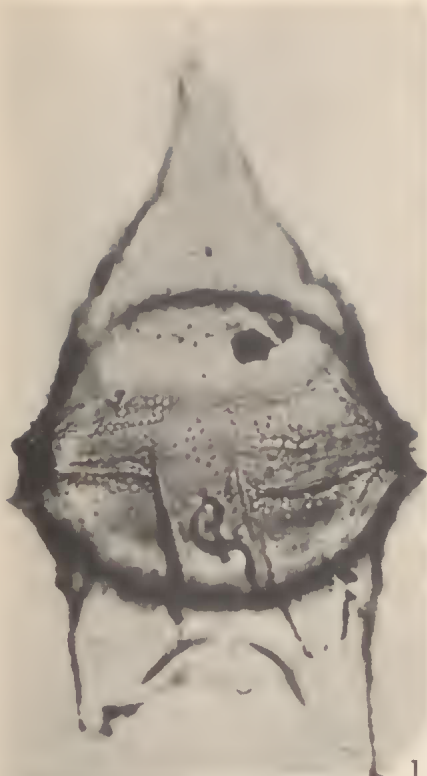
Explanation of Plates

PLATE 16

- Fig. 1, 2—*Deflandrea dartmooria* n.sp. ventral and dorsal surfaces of holotype. 1, ventral surface \times *c.* 650; 2, dorsal surface \times *c.* 450.
 Fig. 3-6—*Wetzeliella hyperacantha* n.sp. 3, paratype P24088 \times *c.* 600; 4, showing archeopyle \times *c.* 600; 5, holotype \times *c.* 600; 6, showing apical horn and arrangement of surface appendages \times *c.* 500.
 Fig. 7, 8—*Cordosphaeridium bipolare* n.sp. \times *c.* 800. 7, paratype P24082; 8, holotype.
 Fig. 9, 11—*Baltisphaeridium taylori* n.sp. \times *c.* 800. 9, 11, from Dartmoor Formation. 9, paratype P24084; 11, portion of wall of another specimen; 10, holotype from Rivernook Member of Dilwyn Clay.

PLATE 17

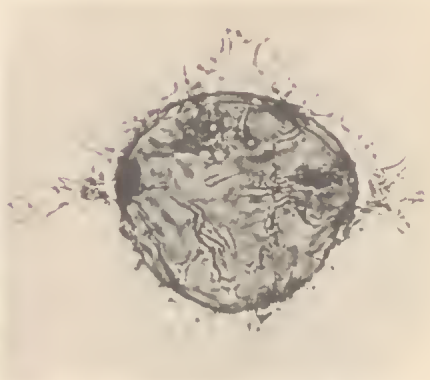
- Fig. 1-4—*Kenleyia pachycerata* n.sp. 1, 4 \times *c.* 500; 2, paratype P24090 \times *c.* 500; 3, holotype \times *c.* 600.
 Fig. 5, 6—*Kenleyia leptocerata* n.sp. 5, paratype P24091 \times *c.* 600; 6, holotype \times *c.* 500.
 Fig. 7, 10—*Kenleyia lophophora* n.sp. 7, \times *c.* 600; 8, holotype \times *c.* 500; 9, \times *c.* 600; 10, paratype P24174 \times *c.* 600.



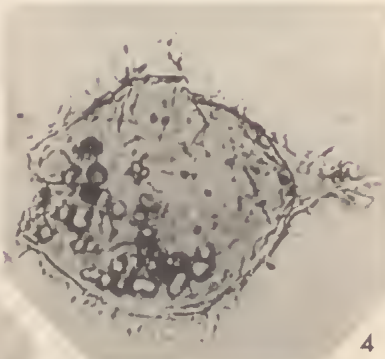
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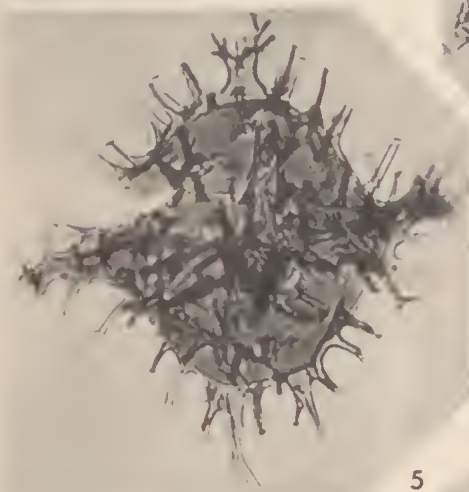
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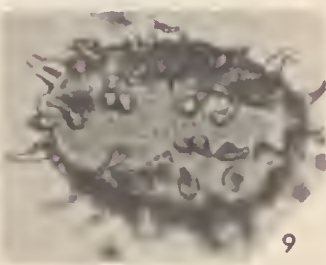
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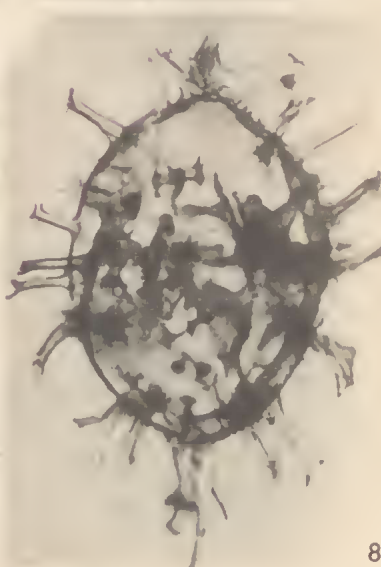
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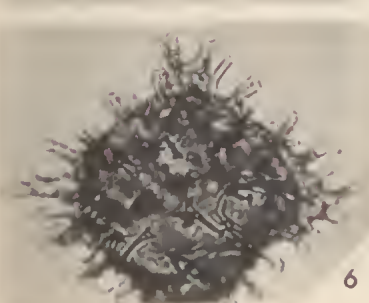
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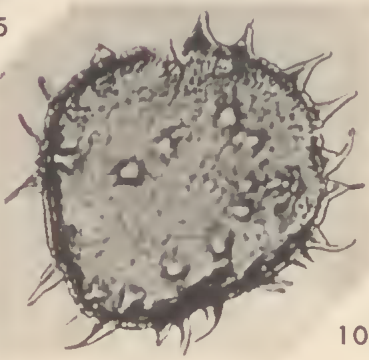
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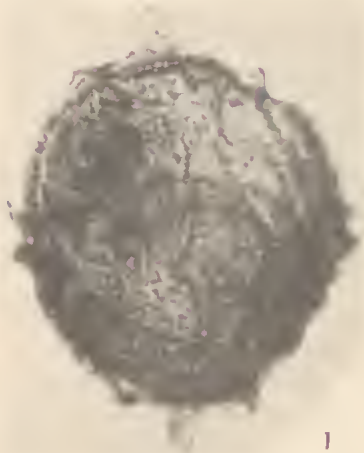


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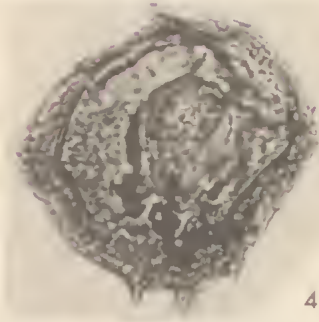
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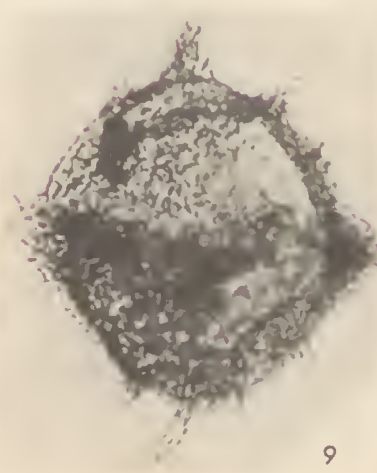
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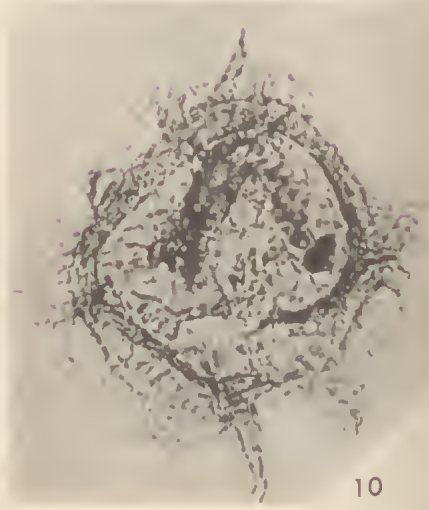
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